

## **APPENDIX B**

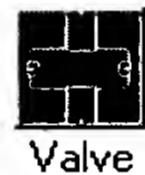
## General Icon Properties

Two distinguishable colors representing channels on different layers. Red in this case representing the control channel and blue the fluidic channel. There are typically two ports on each of the channels represented by white circles, or dots, sometimes outlined with black circles. Some of the icons will only have one color representing a channel only present on one layer and others will have two colors representing components composed of multiple channels on multiple layers.

### Orientation

The orientation of the components in the icons does not represent its final placement in the microfluidic design. Once the component is placed, it can be rotated with freedom to any degree (0 – 360).

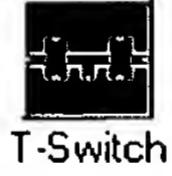
## Valve



### Description:

The valve icon represents the basic switching element and consists of channels of different widths and lengths with connection points, or ports.

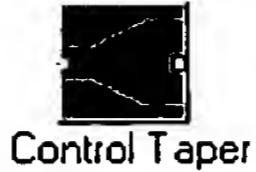
## T-Switch



### Description:

The T-Switch represents a basic component that is used to direct the incoming flow in the fluidic channel to none or one of two channels based on the state of the control channels. The channels for both the fluidic and control layer can be of different widths and lengths with connection points, or ports.

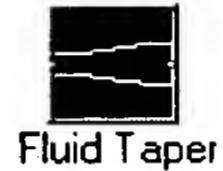
## **Control Tapers**



### Description:

The Control Taper is a basic component that allows a connection from a larger control channel to a smaller control channel or visa versa. The ends of the tapers can be of different widths based on the needed geometries of what needs to be connected.

## **Fluid Taper**



### Description:

The Fluid Taper is a basic component that allows a connection from a larger fluid channel to a smaller fluid channel or visa versa. The ends of the tapers can be of different widths based on the needed geometries of what needs to be connected.

## **Peristaltic Pump**



### Description:

The Peristaltic Pump is a basic component that allows the active control of fluid in either direction. The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation.

## **Pump and Dampener**



### Description:

The Peristaltic Pump and Dampener is a basic component that allows the active control of fluid in either direction and includes dampening channels to smoothen the flow of fluid.

The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation.

## Multiplexers



### Description:

The Multiplexers are basic component that allows the active control of fluid in 8 or 16 fluid channels based on a binary application of control signals to the control channels. The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation. In general, these icons can be extended to cover N fluid lines controlled by  $2\log N$  control lines.

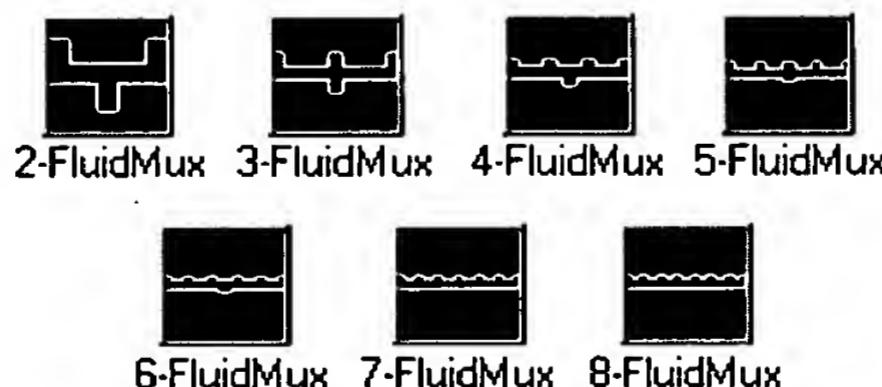
## Rotary Mixers



### Description:

The Rotary Mixers are basic components and come in different configurations based on the application needs. The Rotary Mixer comes in three basic variations of the fluid input and output ports: 2 fluid input/output (I/O), 3 fluid I/O, and 4 fluid I/O. The Rotary Mixer Sq has a different topology which allows “tiling” of the mixers and comes in two basic variations of the fluid input and output ports: 2 fluid input/output (I/O) and 3 fluid I/O. The actual channels, both fluidic and control, can be of different widths based on the geometries required for proper operation.

## Fluid Mux Connectors



The Fluid Mux Connectors are basic components that are sized and positioned to work the Multiplexer and Channel Array Components. These icons represent the “mux” connections from 2 through 8 array or multiplexer outputs or inputs.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

## Bridges

The purpose of the Bridge component is to allow control lines to cross over fluid lines without stopping the flow of the fluid line below it. This feature enables the user to design the chip with more complexity and greater density. Note: The flow line is not completely unaffected because the membrane of the bridge component will deflect when the control line is actuated. The amount of deflection will depend upon the amount of pressure that is applied to the control line.

## Channel Arrays

The channel array provides a set of individually addressable flow lines. The number of control lines is equal to the number of flow lines for this component. The flow of the liquid within the array can be controlled in any fashion by actuating the necessary control lines.

## Control Components

The Control components allow the Control lines to be arranged in the configurations required by the user. The dimensions of these components have been established using the minimum recommended lengths for the individual components.

## Dampeners

The Dampener elements are used provide smoother flow of pumped liquid. The membrane of the Dampener element will deflect and absorb the energy caused by the closing of the valves of the peristaltic pump.

## Fluid Components

The Fluid components allow the Fluid lines to be arranged in the configurations required by the user. The dimensions of these components have been established using the minimum recommended lengths for the individual components.

## Fluid Mux Connectors

The Fluid Mux Connectors enable the user to interface the flow lines of the Multiplexer and Channel arrays to other components. They have been designed to match the flow line spacing for these components.

## Mixers

The Mixers are used to mix two or more different liquids within a closed loop. Mixing is accomplished by pumping the liquid around the closed loop. Parabolic flow of the liquid within the loop allows for fast and efficient mixing. The different Mixer orientations allow the user to arrange the mixers in various configurations (arrays, etc.) depending upon requirements.

## Tapers

The taper element is required when varying the width of the control lines or the fluid lines. This requirement is necessary because of the manufacturing process involved in making the molds for the chips.

## Multiplexers

The Multiplexer element allows the user to flow liquid in any single flow line at a given time using a predetermined control scheme. The number of control lines required for a given multiplexer can be calculated using the equation  $2(\log_2 N)$ , where

**N** is the number of flow lines. The advantage of the Multiplexer becomes more obvious as larger arrays are used, where the number of control lines can be significantly less than the number of flow lines.

### Pumps

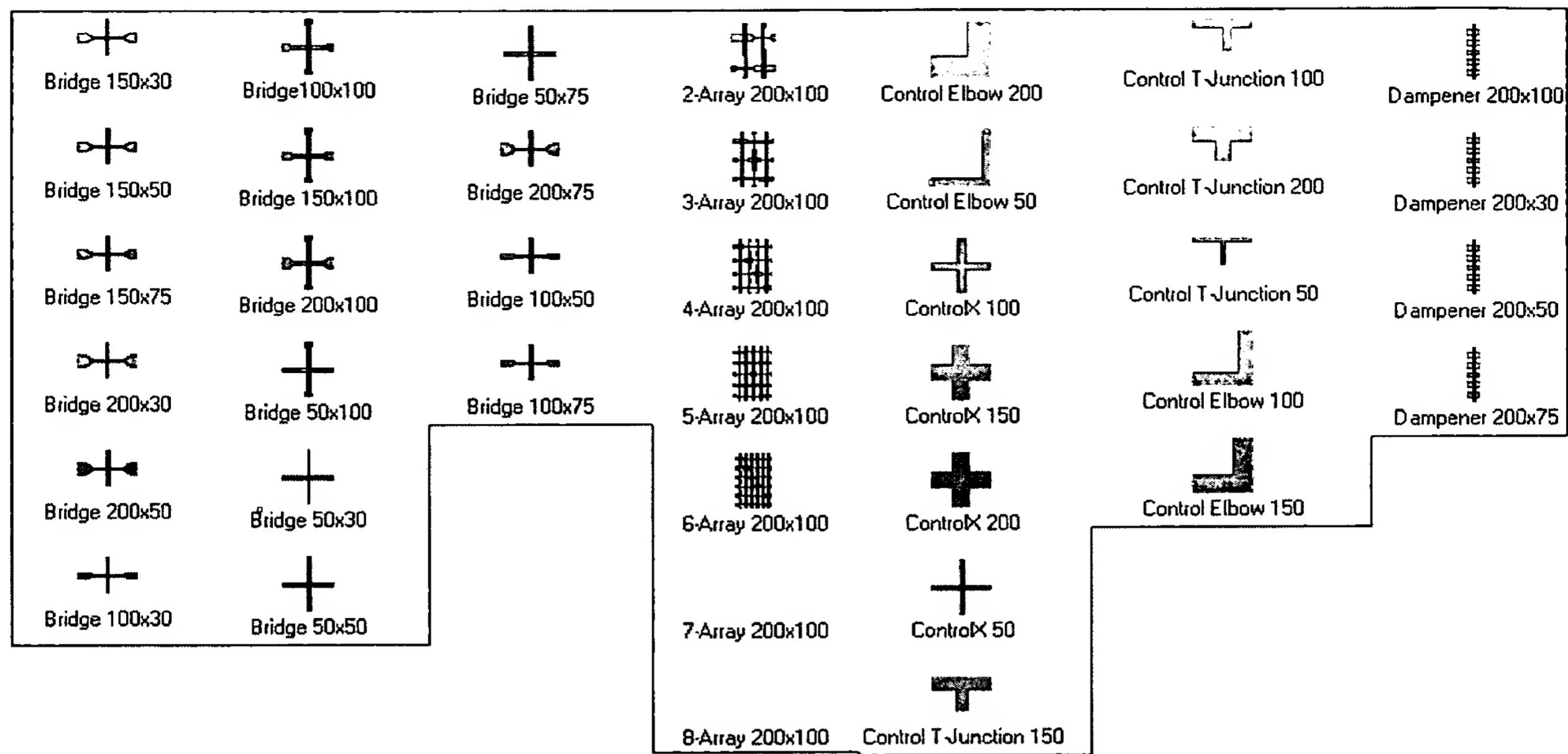
The Pump element is a peristaltic pump which is composed of three individual valves. The liquid within the flow lines are pumped by sequentially actuating the individual valves. The Pump can be used with or without the Dampener element.

### T-Switch

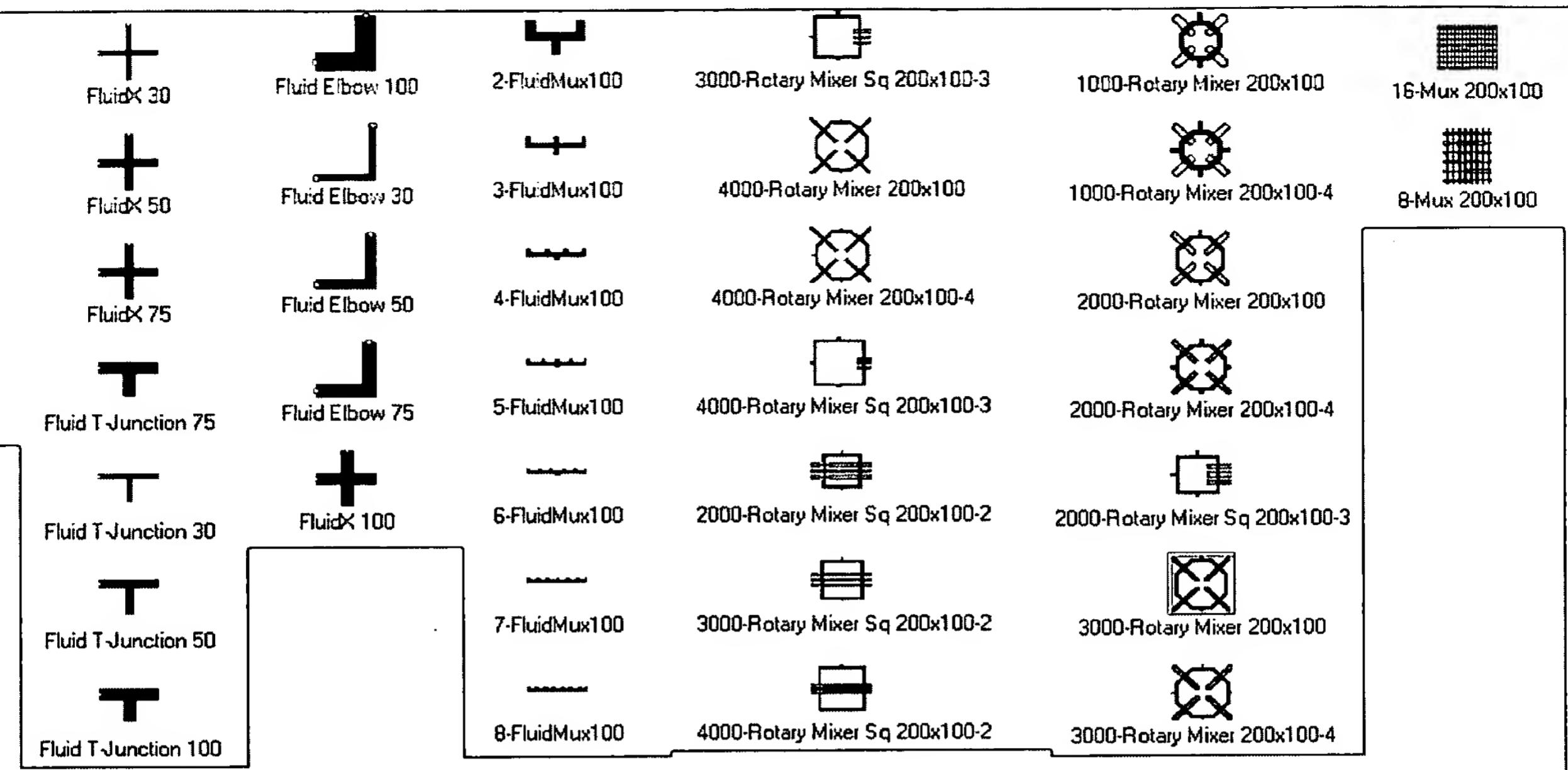
The T-Switch element allows the user to control the input of two flow lines into a single flow line or vice versa. The valve elements can be used to turn the flow of each input on and off so that the desired liquid runs through the single line or the valves can be used to separate the flow from a single line to two lines.

### Valve

The valve element is used to turn the liquid flow on and off. This is controlled by providing sufficient air pressure to cause the membrane to deflect and pinch off the flow line.



100 200 300 400 500 600 700 800 900 1000



100 200 300 400 500 600 700 800 900 1000

